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A Curriculum Package of Social and Ethical Concerns in Metaverse Ecosystem in School Education Based on Bloom's Taxonomy

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Abstract: Facing the newly emerged blockchain technology in metaverse construction, the instructional design, pedagogy, and curriculum package of the metaverse ecosystem is underdeveloped or under-researched in education locally and globally. Proponents of metaverse education mostly focus on its application in the virtual world without thoroughly thinking about its connections between the physical world and virtual world. Metaverse construction not only provides lots of work-from-home business and studying opportunities during the considerable impacts of COVID-19 but also raises lots of social and ethical issues such as data privacy, virtual identity, investment/security risks, system integrity, social media toxicity, and corporate control problems. There is an urgent need to address such social and ethical concerns in some curriculum packages of metaverse education. Based on this perspective, this paper aims to develop a curriculum package of addressing some social and ethical concerns in daily-life applications of blockchain technology in upper secondary (K10-K11) education. Through the six levels of Bloom's taxonomy framework, course materials have been developed to provide the value-laden ecosystem concerning decentralized properties and the digitalization of IoT and STEM metaverses in some lessons. This paper also endeavors to help those participating K10-K11students raise their social and ethical awareness during the course development of a curriculum package related to metaverse literacy.

Keywords: Metaverse literacy, social & ethical concerns, curriculum package, Bloom's Taxonomy

1. Introduction

Metaverse is a current and future integrated totality of the physical world and virtual world connecting internet-of-things (IoT) and other aspects of human lives with a wide range of applications of (wired / wireless) computer networks, handheld mobile devices, augmented reality / virtual reality / substitutional reality / mixed reality / extended reality, artificial intelligence (AI) and robotics. Currently, metaverses provide a range of human imaginations and potential functionalities that enable new modes of e-business, e-trades, e-digital currencies and e-learning, and lots of immersive social and virtual experiences in STEM education and game-based learning (GBL). IoT and STEM metaverses refer to focused uses of internet-of-things (IoT) and STEM applications respectively in daily lives connecting the physical world and virtual world in metaverses.

The newly evolved Blockchain technology is a peer-to-peer decentralized, distributed ledger that keeps digital assets transparent and unchangeable without the involvement of any third-party intermediary. In particular, bitcoin is a cryptocurrency and one application of blockchain technology. Notably, there are some system integrity, privacy threat, and (monetized) data insecurity problems found in the uses of blockchain technology such as immoral and illegal withdrawal of e-cash or e-currencies in bitcoins, causing the possible financial crisis in national, regional, and global economies (Fromkin, 2022; Longstaff, 2019). Recently, an increasing number of ICT educators have paid heed to ethical and legal concerns of blockchain technology such as privacy, security, environmental impacts, loss of human jobs, and investment risks in metaverse education (Houlding, 2019). Students and teachers ought to be cautious with those underlying ethical and legal issues, and some social inequity problems like potential bad impacts of blockchain technology upon those elderly and disadvantaged ICT-illiterate persons. Owing to the threats posed by the pandemic, metaverse construction not only provides lots of work-from-home business and studying opportunities but also raises lots of social and ethical issues such as virtual identity, data privacy, social media toxicity, and corporate control

problems (Djordjevic, 2022). There is an urgent need to address such social and ethical concerns in metaverse education (Gurmen, 2022) and to develop suitable curriculum packages locally and globally.

2. Metaverse Ecosystem

In a balanced metaverse ecosystem, arts/sports/Green STEM activities in the physical world need to be involved whilst game-based learning /AI & robotics / digitalized STEM activities in the virtual world also need to take place through industry-market collaboration. Participating students and teachers in the earlier stages of the project have enriched and connected their real-world and virtual-world learning experiences through the IoT bridge. Mere one-sided physical or virtual world explorations might limit their learning experiences without inter-world connections.

3. Research Project

Facing the newly emerged blockchain technology and metaverse construction, the instructional design, pedagogy, and curriculum packages of the ecosystem of metaverses using blockchain technology have been under-developed and under-researched in education locally and globally (c.f. Hirsh-Pasek, *et al.* 2022). And the main reason for using the six-level Bloom's Taxonomy in the project is to use a widely accepted academic standard to evaluate the quality of the curriculum package and measure participating students' cognitive gain in the ecosystem of the mentioned metaverses. In this project, two key features of metaverses related to KT are investigated in table 1. The main reason why a group of upper secondary school students will be selected is that lower secondary and primary students cannot master blockchain technology without any fundamental concepts of shareability and scalability of databases and advanced programming techniques and tertiary students are not selected properly due to their tight studying schedules and short school semesters, in comparison with upper secondary ones.

Table 1. *Two key features of metaverses and socio-cognitive functions in student activities*

Key Features of Metaverses	**Socio-cognitive Functions in Two-way Knowledge Transfer (KT) model**	**Students' exemplified activities in IoT and STEM metaverses**
Decentralized	Communal ownership enhances socialization and externalization in KT	Students learn blockchain to understand the importance of communal ownership for e-trade transactions, tokens, e-marketing prices & bitcoins
Digitalization	Monetization in digital currencies to build value systems of buying goods and consuming services in combination (cognitive synthesis) in KT	In digital currency ecosystems using blockchain technology, students use e-cash coupons in AI shops to buy / sell products and services in metaverses

The objectives of the current project are:
a. To develop and fine-tune an innovative curriculum package of the value-laden ecosystem (concerning decentralized properties and digitalization) of IoT and STEM metaverses (using blockchain applications) in education using Bloom's Taxonomy framework
b. To help upper secondary students raise ethical awareness during daily life applications of Blockchain technology using Bloom's Taxonomy framework during the course development of curriculum package in catering for their learning diversity in some studying classes

Notably, some value-laden parameters in the objective **a** like core humanistic values of blockchain uses in metaverses, moral conscience of investors in bitcoins, and ethical and equity concerns in metaverses ecosystem have been added to the curriculum package. Research subjects are 60 upper secondary (K10-K11) students (in three classes of 20 students) in Hong Kong and 6 employed teaching mentors are some undergraduate students in universities or come from some NGOs (with undergraduate major in AI, educational technology, computer engineering or computer science) during the two testing periods.

4. Curriculum Package

The curriculum package in normal classroom or after-school settings contains beginners / intermediate / advanced learner levels of learning topics / studying themes related to social and ethical concerns of ten lessons per class, based on Bloom's Taxonomy; and some exemplars of individual course assignments and group project involving coding design on some social and ethical concerns related to blockchain applications in some IoT and STEM learning activities with continuous, summative and formative assessment rubrics. Initial lesson contents (two lessons per topic) on blockchain technology in the metaverse ecosystem include subject knowledge on blockchain technology and conditional knowledge in the metaverse literacy framework and applied knowledge related to social and ethical concerns in the following table 2.

Table 2. *Types of Knowledge on Blockchain Technology in School Education*

Subject (propositional) knowledge	**Conditional (meta-cognitive) knowledge in metaverse literacy framework**	**Applied (procedural) knowledge in social and ethical concerns**
1. Historical development of different blockchains in local and global contexts	Students know how to: ● use, provide and communicate information on blockchain technology ethically and responsibly ● have effective and ethical uses of information for their lifelong learning (EDB, 2018)	Students are instructed to do group presentation projects on raising their moral awareness and categorizing types of ethical issues (data privacy, virtual identity, investment / security risks, system integrity and social media toxicity problems) towards daily-life uses of blockchain technology
2. Ethereum, EVM and solidity coding 3. Various applications of EVM blockchain 4. NFT metadata structure and storage 5. Future development, Proof-of-work vs Proof-of-stake	Students know how to: ● use technology to improve use of digital information ● research effectively and responsibly (The Ministry of Education and Child Care, British Columbia, 2022)	Students are instructed to do literature review in group projects on using blockchain to address problems about its social and ethical impacts on information societies and endeavor to find out feasible solutions or alleviate those problems using their subject (proposition) knowledge

Three normal or after-school classes of mixed-ability groups of upper secondary students in 2022-23 have been instructed to do various learning tasks of the beginners / intermediate / advanced levels in class activities and group projects works in the two testing periods. Students and mentors of the first two classes will help refine the curriculum package with some studying topics / learning tasks using the six levels of Bloom's Taxonomy in their individual course assignments and group project works. The third class in later stages will further help refine the topics / tasks of the revised version of the curriculum package after interim evaluation. Table 3 provides a six-level of seeking explanations and guided studying tasks and table 4 provides a three-level structure of learners in the instructional design of the curriculum package on social and ethical concerns of blockchain technology.

Table 3. *A Six-level Structure of Seeking Explanations and Guided Studying Tasks / Questions*

Levels of BT	Seeking-explanations in instructional design of the curriculum package	Guided students' studying tasks / thinking questions in curriculum package
Remembering / Recalling	Students is instructed to recall and recite the concept of blockchain learned from relevant digital data sources	'What is blockchain'?
Understanding	Students can explain the relationships between the two concepts in their own words	'How are bitcoins related to blockchain technology?'
Applying	Students can give particular examples of some concepts in their daily encounter	'How is blockchain used in digitalization of metaverses? Please give some examples.'
Analyzing	Students can analyze the whole organizational structure of the codes / programs in terms of its individual components and finding their interrelationships in given codes / programs	'Please find out some / all logical errors in the given codes / programs involving the decentralized properties of metaverses.'
Extending/ Synthesizing	Students can extend the given codes to other learning scenarios and put parts into a whole to work out a flow chart / coding system	'Please write a flowchart / a simple system to perform some decentral features of database using the program codes.'
Creating / Evaluatig	Students can make value judgments by comparing the advantages and disadvantages of both 'bottom-up' and 'top-down' approaches in databases in blockchain applications. Some even crease their own blockchain coding system.	'Given the two 'bottom-up' an 'top-down' approaches i databases, which is the best suitabl one for blockchain applications And why?' 'Can you create a ne blockchain coding system?'

(modified from. Starr, Manaris, & Stalvey, 2008)

The whole curriculum package in daily-life applications of blockchain technology has a wide range of learning topics / tasks at beginners / intermediate / advanced levels using Bloom's Taxonomy (BT) framework in the following table 4.

Table 4. *A Three-level Structure of learners Using Bloom's Taxonomy in the instructional design*

Levels of learners	Production of knowledge in individual assignments and group projects	Seeking-Explanations Aspects for production of knowledge
Beginners	Recalling / remembering	Understanding
Intermediate	Applying	Analyzing
Advanced	Extending / Synthesizing	Creating / Evaluating

(Modified from. Starr, Manaris, & Stalvey, 2008)

5. Potential Contributions of the Curriculum Package

Owing to its limited length, this paper merely highlights some social and ethical concerns in daily-life applications of blockchain technology in a metaverse ecosystem connecting the physical and virtual worlds. The curriculum package enriches local and global curricula in metaverse education, especially curriculum development in the metaverse ecosystem on its digitalization and decentralized properties, and adds more value-added parameters to social and ethical concerns in local and international secondary curricula related to metaverse literacy.

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